GROUNDWATER INVESTIGATION

Gamber Area

Carroll County, Maryland

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Gamber Groundwater Investigation

1.0 Introduction

The Maryland Environmental Service (MES) was retained by the Maryland Department of the Environment (MDE) Oil Control Program (OCP) to conduct a groundwater investigation in the Gamber area of Carroll County, Maryland. The assessment is in response to the OCP case number 2005-1155CL, to investigate the extent and possible sources of petroleum constituents found in area domestic and non-community water supply wells. The area of concern surrounds the Gamber area at the intersection of Sykesville Road (Rt-21) and Gamber Road (Rt- 91) (Figure 1). The approximately 30-acre site encompasses ten (10) OCP cases, three (3) are closed and seven (7) are still open. As of this time, twelve (12) underground storage tanks (UST) sites have been identified; some are still in service and some have been removed. A large-scale map of the study area, showing all relevant features (Figure 1), is enclosed with this report for reference. A proposal outlining seven (7) tasks to be performed was proposed by MES, subsequently edited, and approved by the MDE. Copies of those documents can be found in Appendix D. A short photographic summary of the investigation can be found in Appendix C.

2.0 Task I – File Compilation and Review

2.1 Site History

Historic and ongoing investigation information from the MDE - OCP and Carroll County Environmental Health Department (CCHD) was used to construct a summary of events and current status of groundwater in the Gamber area. As part of our assessment of the Gamber area, MES reviewed MDE and CCHD case files to obtain both historic as well as the most recent sample analysis and have summarized the information. All sample information and current and former tank locations have been incorporated into the GIS database. The list of potential sources is not limited to these cases. Information on the history of the cases below helps to identify potential sources that have been investigated by MDE to date. Sampling results for all monitoring wells can be found in Table 6; domestic and commercial well in Table 7.

2.2 MDE Cases

2005-1001CL Royal Farms Store 4007 Sykesville Road ***Open***

Gasoline sales began October 7, 2002. Water supply well tested 34.7 parts per billion (ppb) MTBE by CCHD on March 18, 2005, currently treated by a GAC system. Water samples taken in February and June 2006 were non-detect for MTBE (before treatment).

September 3, 2003	Installed one 30,000 gal gasoline tank and one 12,000 gallon diesel tank
June 8, 2005	MDE noted diesel fuel in two sumps and weeping dispenser lines and improperly maintained basins and spill catch basins improperly maintained. Problems were corrected.
July 9, 2005	Conducted helium test on system – tested tight
July 22, 2005	Monitoring wells were sampled - RF-1 non-detect RF-2 non-detect, RF-3 MTBE 290ppb, naphthalene 9.1ppb

June 30, 2006 RF-3 MTBE level decreased to 21ppb

1990-2240CL High's Dairy Store 3949 Sykesville Road ***Closed***
2005-1013CL ***Open***

The site has dispensed petroleum products for over twenty (20) years under differing owners. Supply well at site has tested non-detect for VOCs.

December 5, 1990 MDE oversaw removal of two (2) 1,000 gal steel gasoline tanks and one 550 gal steel kerosene tank. No perforations were observed and but a strong odor in soil was noted. A monitoring well was installed, tested non-detect and the case was closed. (1990-2240CL)

June 26, 1996 New tanks installed by Highs. Petroleum impacted soils were removed (approximately 586 tons) and properly disposed.

September 13, 1996 Completed instillation of three (3) new USTs

July 12, 2005 Three (3) monitoring wells (H-1, 2 & 3) were installed. Tanks tested tight August 8, 2005.

1995-1752CL Discover Carpets 3950 Sykesville Road ***Closed***
2006-0053CL ***Open***

Site had various uses and owners over the years including a gas station, an auto body shop, car wash, car sales, and an apartment. Currently the property is a vacant commercial building with a second floor apartment and a vacant auto repair building in the rear. The supply well has shown test results for Benzene exceeding the maximum contaminate level (mcl) of 5 ppb since 2003, with other test date results as high as 76.3 ppb (Apr-05). The most recent sample (Nov-06) showed a Benzene level of 8 ppb. Drinking water is filtered through a GAC system - installed on or about August 1, 2005. Two (2) monitoring wells (MW1 & 2) were installed by MES near the former tank field as part of this investigation. The UST history is as follows:

January 26, 1995 Four (4) gasoline tanks were removed. MDE noted no perforations, no soil or water samples taken. Case 1995-1753CL was closed.

December 1, 2005 MDE observed the removal of a 550-gallon heating oil tank. Some rust and pitting no perforations noted. Soil sample taken – non-detect.

January 16, 2006 MDE observed the removal of a 550-gallon waste oil tank. Some rust observed but no perforations. Soil sample taken, results non-detect.

Drinking well testing results:

9/21/2003 Benzene-63.4 ppb, TAME-.63 ppb
1,2 Dichloroethane-17.7 ppb, Napthalene- 8.34 ppb

6/14/2005 Benzene- 76.3 ppb, 1,2 Dichloroethane- 26.7, Naphthalene- 11.4 ppb

8/30/2006 Benzene- 16.5 ppb, MTBE- 3.1ppb

1992-2124CL Wantz Construction 4004 Sykesville Road ***Closed***

April 3, 1992 After a reported tank test failure, MDE observed the removal of a 550-galon gasoline tank. The tank was in poor condition with severe surface pitting. No perforations were observed. Soils were tested on site with a Photoionization Detector (PID). The results were non-detect. Case 1992-2124 was closed

The drinking well was sampled 8/11/2003, 3/30/2005 & 4/22/05 all samples were non-detect for petroleum constituents.

2004-1015CL Former Gamber V. F.D. 4000 Sykesville Road ***Open***

The property was sold to State Highway Adm. prior to March 2004 and then to Later, LLC (Unglesby). The building now used to install "Line-X" spray on truck bed liners.

December 13, 2003 MDE observed the removal of a 275 gal. UST. Which has been out of service for at least 20 years. Perforations were observed and a soil sample taken – results were below action levels.

The drinking well was sampled 1/13/2005. The results were non-detect (only analyzed for BTEX). The sample was retested for MTBE January 26, 2004 and the results were non-detect. The drinking well was sampled 4/19/05 by CCHD. The results were below action levels for petroleum constituents.

2004-0140CL Dix Property 1701 Sandra Lane ***Open***

July 7, 2003 Mr. Dix reported "ruptured tank" at 404 Sandra Lane (Wantz). On July 21, 2003 his well was sampled by MDE – results Benzene 58.2 ppb. MDE installed a granular carbon filter system (GAC) system May 9, 2005. Pre-filter samples continue to be above the mcl for Benzene

2005-1155CL Gamber Groundwater Investigation – Sykesville Road ***Open***

Between March, 2005 and August, 2005 twenty-eight (28) drinking wells were sampled for petroleum constituents. Five (5) GAC systems were installed by MDE in addition to two (2) systems previously in place (Royal Farms, Discover). MES was contracted to assist in the investigation. The following residents are involved in this open case:

Mey (4024 Howard La.) – Although no UST sites were identified on this property, the presence of Benzene in drinking water samples was detected in 2003. The highest reported level (128 ppb) occurred in samples taken in May 2005. the Mey residence is served by a GAC filter system. The most recent samples taken (August 2006) showed benzene levels of 76ppb.

Martin (1703 Georgia Ave), Weidman (1704 Georgia Ave), Brower (4016 Sykesville Rd.) – These three residents were identified as having MTBE levels in drinking wells above the action level of 20ppb (Table 6) with the highest levels reported between August and November 2005.

The highest MTBE results were:

Martin	25ppb	August, 2005
Weidman	45ppb	August, 2005
Brower	39ppb	November, 2005

All three houses now have GAC treatment systems and are being monitored. The most recent samples have MTBE levels below the 20 ppb action level. All other residents in the study area have had MTBE levels below 20ppb.

Raver Property 4015 Sykesville Road.

April 22, 2005	MDE observed out of service No. 2 heating oil tank
June 16, 2005	MDE observed a partially uncovered underground gasoline storage tank

November 29, 2006 New owner stated to MES personnel, during the course of this investigation, that both tanks have been removed and soil tested. MDE files had no further information.

The drinking well was sampled 3/25/2005 by CCHD - MTBE - 0.87 ppb. The owner refused site permission for further investigation.

2.3 Well Inventory

In order to better understand the local water use and hydrologic conditions, an inventory of wells drilled under permit located within 1,000 feet of the intersection of Sykesville Road (Rt-32) and Gamber Road (Rt-91), was requested from the MDE, Wells and Septic Program. The table below, retrieved directly from the MDE database, lists wells drilled under permit within one-half (1/2) mile of the intersection of Rt-32 and Rt-91. Duplicate names in the chart are wells drilled for builders as the owner of record at the time the permit was issued. A field reconnaissance identified twenty-one (21) domestic wells and seven (7) commercial wells in the study area. Only seven (7) of those wells have well tags attached (field observation) and of those, four (4) could be identified on the chart. The MDE, Wells and Septic Program provided information on the three (3) that did not appear on the listing, and were added to the MDE chart. Since most of the wells in the study area were not listed, it can be assumed that they were drilled (or hand dug) prior to the drilling permit regulations being promulgated. The average depth of the wells listed is approximately 192 feet, with an average static water level of approximately 40 feet. All domestic and commercial wells in the study area were located by GPS and are shown on the Gamber Study Area map (Figure 1). The following table (Table 1.) combines the MDE database and the additional field identified wells.

Table 1. Well Inventory

PERMIT	OWNER_NAME	ROAD_NAME	TOTAL DEPTH	LEVEL BEFORE
CL815308	GOGLIA TOM	3877 GAMBER RD		
CL739538	CHIOSI LOUIS	RT 32	165	40
CL740752	LAKELAND DEVL CORP	GAMBER	105	30
CL810314*	ABAR PTR	DOUBLE TAKE SALON	125	39
CL813396	LYNN LEE CONST CO	CANTERBURY DR	145	15
CL813920	WEISHAAR DOUGLAS	4102 SYKESVILLE RD	300	35
CL814072	ARRINGTON VIRGINIA	4019 SYKESVILLE RD	100	30
CL814510	CLAYMOTTE CORP	RT 91	125	37
CL814545	CLAYMOTTE CORP	RT 91	150	36
CL814546	CLAYMOTTE CORP	RT 91	125	24
CL880501	CASE E CRAIG	SYKESVILLE RD	130	46
CL881519	TIMCHULA STEPHEN	ROUTE 91		
CL882131	SHIPLEY & HOFF JOINT	CHRISTIAN CART	250	54
CL882162	DAVIDSON ALLAN R	ROUTE 91		
CL882163	PARKS MARVIN K	SYKESVILLE 32		
CL882184	CLARK MARVIN K	SYKESVILLE RD 32		
CL882409	ROSE NANCY	NINER	120	22
CL882583	RAY JOSEPH H	POOLE RD		
CL882895	BROTHERS LUTHER	3899 SYKESVILLE RD	260	50
CL883040	SHIPLEY & HOFF JOINT	CHRISTANA COURT	200	45
CL883079	LEONARD RICHARD A	SYKESVILLE		
CL920273	SHIPLEY & HOFF JOINT	CHRISTANA COURT	400	51
CL920274	SHIPLEY & HOFF JOINT	AMANDA LANE	160	35
CL930509*	HIGHS OF BALTIMORE	HIGHS	225	43
CL940440	ARNOLD JOHN B	4118 SYKESVILLE RD	56	37
CL941383	TEITT SARAH	4125 SYKESVILLE RD	85	41
CL942203	KITCHEN JOHN	POOLE	200	42
CL942204	KITCHEN JOHN	POOLE	200	20
CL942205	KITCHEN JOHN	POOLE	400	42
CL942206	KITCHEN JOHN	POOLE		42
CL942671	RASH JOHN	4201 POOL RD	300	45
CL944271	EPLER JOAN & KENNETH	4036 SYKESVILLE RD	400	50
CL943473*	WESTM. TRUST	ROYAL FARM	200	51
Wells below were added:				
CL736130*	MEY ARTHUR	HOWARD LA	235	56
CL945414*	SCHACHEL WILLIAM	4047 SYKESVILLE RD		
CL941661*	FLATTER THOMAS	4039 SYKESVILLE RD	205	51
		AVERAGE	192	40

*WELLS IDENTIFIED IN THE FIELD

3.0 Task II – Site Surveying and Mapping

Personnel from the MES-GIS program initiated a site survey using a Trimble RTK survey grade GPS system on November 15, 2006. United States, Coast & Geodetic Survey monuments were located in the Gamber area and were used to achieve the needed ± 1 centimeter accuracy. The field data was collected on November 15 and November 30, 2006 and was downloaded and reduced in the office. The data was then used to create an access database with horizontal and vertical locations which was used to create GIS layers with names and street addresses for domestic wells, monitoring wells, relevant features such as streams, abandoned UST and active UST locations and homes and businesses with POET systems. In order to help visualize the relationship between the potential sources and known well contamination, a site map on a photo base was created to show all features of the study area (figure 1). Both domestic and commercial wells are identified by street address. More specialized maps were then created in ARC-MAP with Auto Cad layers to show groundwater contours (Figure 9) to predict groundwater flow and develop geologic cross sections (Figures 6,7 & 8). File information from MDE and the CCHD along with laboratory results from samples taken from the new monitoring wells, was used in GIS to show contamination plumes (Figure 10).

4.0 Task III Fracture Trace Analysis

4.1 Geology / Hydrology

The Gamber study area, surrounding the intersection of Maryland Routes 32 and 91, lies completely within the Piedmont Province of Maryland. The Piedmont is characterized by rolling terrain varying from gentle slopes to, in some areas, slopes greater than 15%. Geologic maps show the area to be underlain by the rocks of the Wissahickon formation (undifferentiated) described as a "Muscovite-chlorite schist, chloritoid schist, and quartzite; intensely folded and cleaved". The Wissahickon Formation dominates the underlying geology of the southeastern portion of Carroll County as can be seen in The Geologic map of Carroll County (Figure 2). The rocks of the Wissahickon are also of probable Lower Ordovician to Lower Cambrian age. In Maryland the generalized name, Wissahickon formation, is currently being replaced by more area specific and descriptive designations. The remapping of the Wissahickon formation in Carroll County has not been completed so, for this reason, the name "Wissahickon" will be used for this report.

The name "Wissahickon" was first used by Bascom (1902) in Pennsylvania, then Mathews (1904) in Maryland. Southwick and Fisher (1967) recognized five formations within the Wissahickon: Lower Pelitic Schist, Boulder Gneiss, Metaconglomerate, Metagraywacke, and Upper Pelitic Schist. Crowley (1976) recognized six formations within the Wissahickon: Loch Raven Schist, Oella Formation, Piney Run Formation, Sykesville Formation, Pleasant Grove Schist, and Prettyboy Schist. The Pleasant Grove Formation, in particular, had previously been included in the Peters Creek Schist (Knopf and Jonas, 1923) or Peters Creek Formation (Knopf and Jonas, 1929). Hopson (1964) considered the Peters Creek Formation to be a discontinuous turbidite facies within his Western Sequence of the Wissahickon (comparable to the upper pelitic schist and metagraywacke of Southwick and Fisher (1967).

Surface drainage in the Gamber area is toward Prugh Branch of Middle Run to the north and Morgan Run to the south (Figure 2). Both streams flow directly into Liberty Reservoir, important water supply for Baltimore City and the Freedom District of Carroll County. Groundwater flow, which will be explored in this report, generally follows surface topography. The fractured rock aquifer of the Wissahickon, is replenished by precipitation infiltrating through the soil and in up-gradient areas is the primary source of aquifer recharge. Generally, overlying soil horizons act to absorb and then slowly release infiltrating precipitation. A portion of the precipitation percolates downward through the soil mantle and then may migrate through narrow, interconnected joints, fractures, faults and cleavage planes in the bedrock. However, in areas where fracture zones or solution conduits have formed, percolating groundwater can reach the water table quickly.

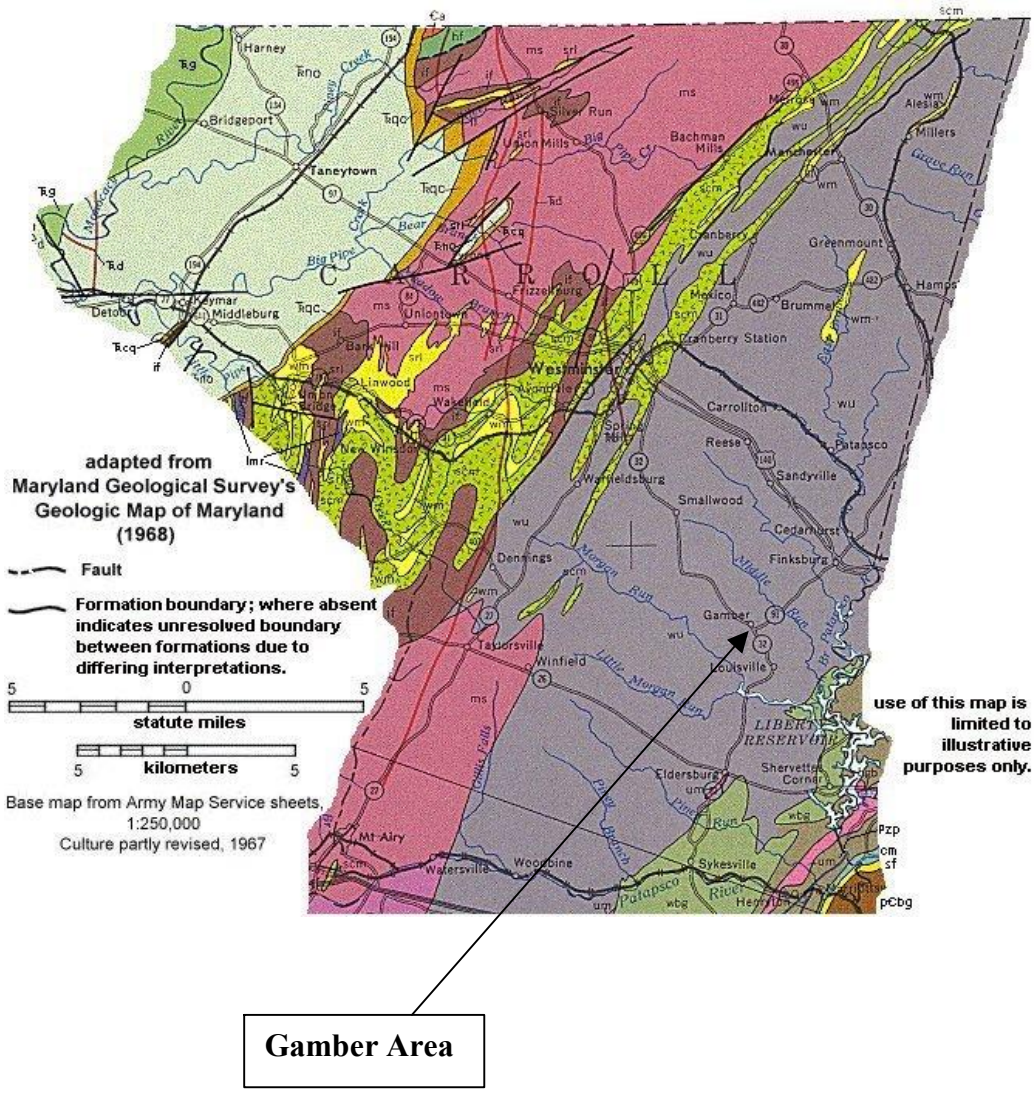


Figure 2 - Carroll County Geologic Map & Site Location

4.2 Fracture Trace Mapping

Carroll County is located geologically in the Piedmont Province of Maryland. The Gamber area, in particular, is underlain by the rocks of the Wissahickon Formation, a highly fractured bedrock, below a highly weathered saprolite zone. Both groundwater and surface flows are influenced by topography and as well as weak or fractured zones in the bedrock. By using aerial photographs, geologic maps and USGS topographic maps, surface features or lineaments that may represent fractures, joints, faults or weaknesses in the bedrock, potential fractures were identified. These features were then plotted in GIS on a topographic base map (see Figure 3 - Fracture Trace Map) of the Gamber area.

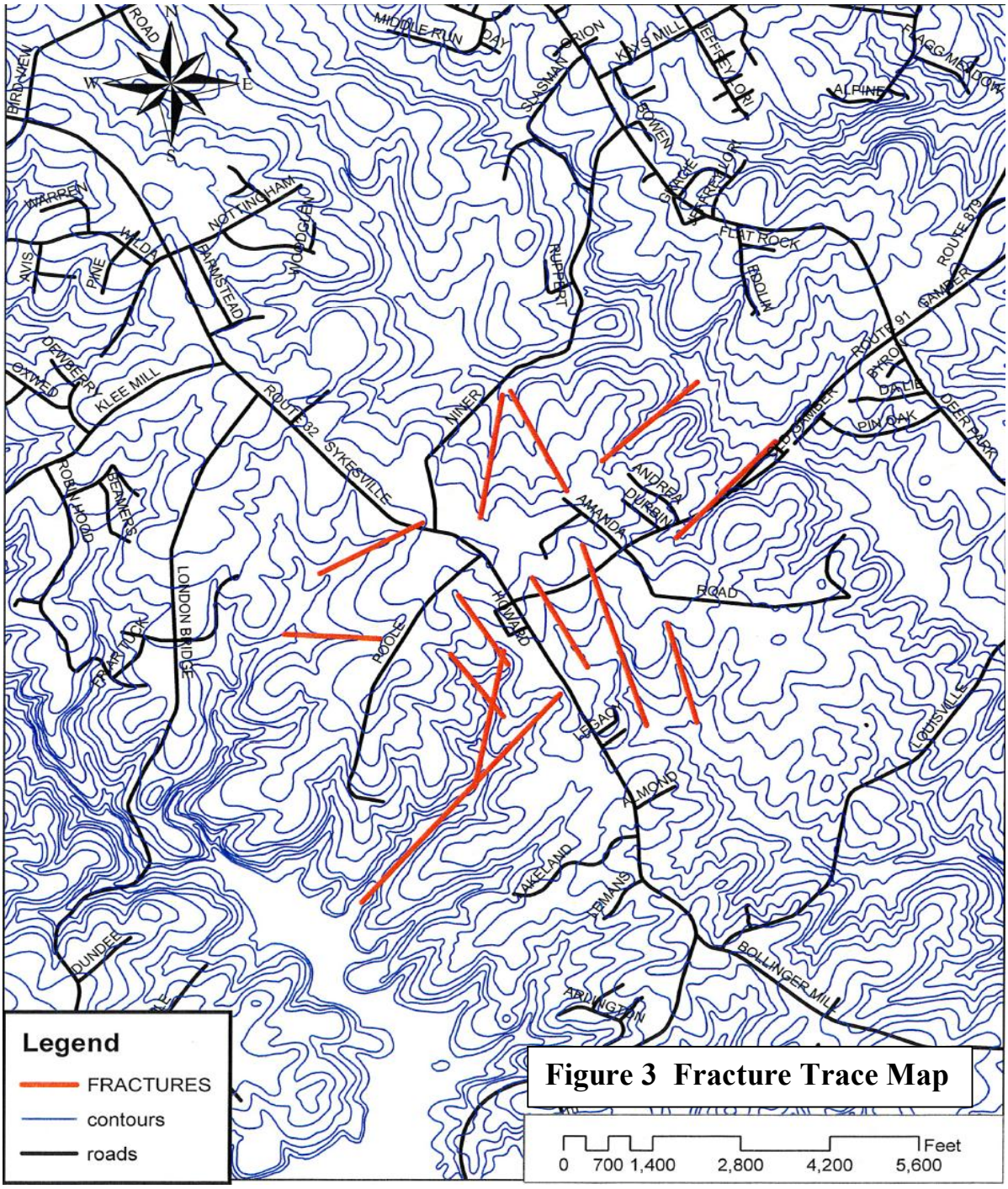
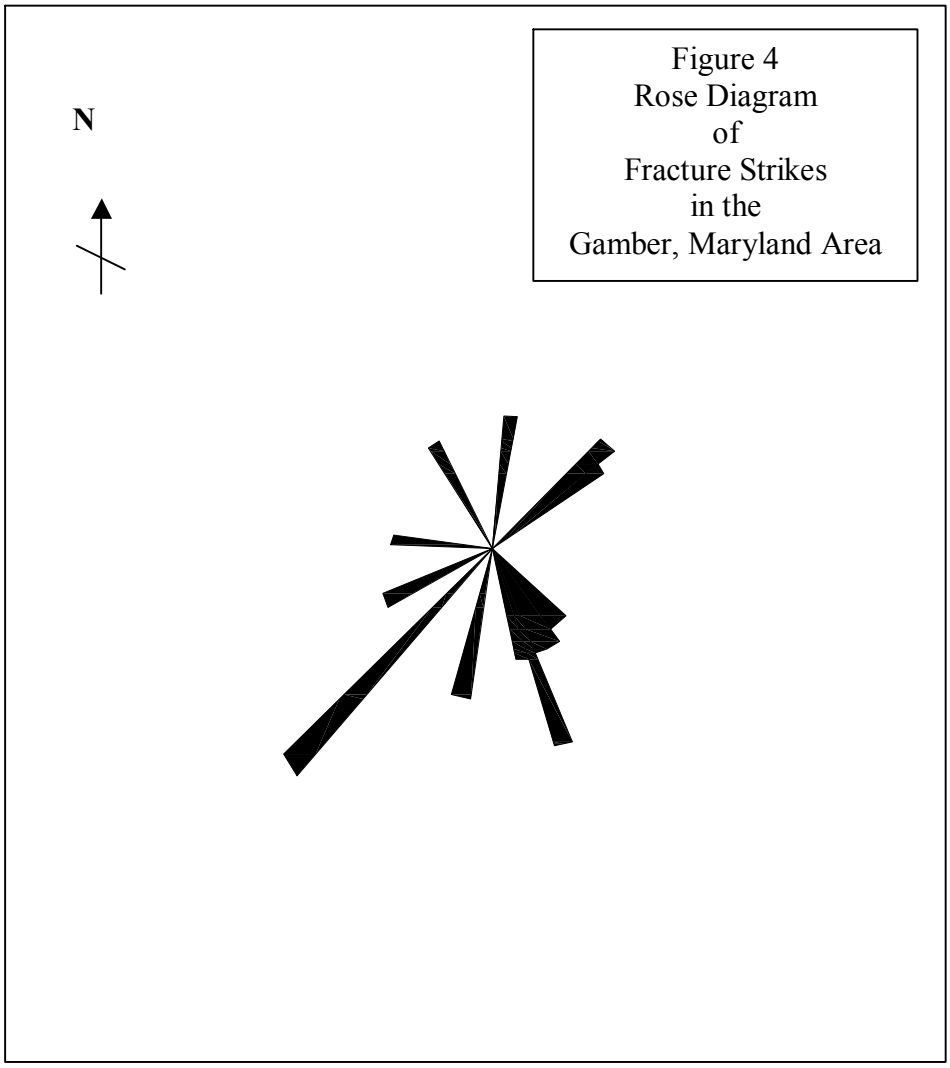


Figure 3 Fracture Trace Map

4.3 Rose Diagram of Fracture Traces

To help identify patterns that could influence preferential drainage patterns, the angles and lengths of the lineaments were measured and used to construct the Rose diagram below. The Gamber study area lies near a hill crest at the intersection of Rt-32 and R-91. Surface drainage is radial as expected. Fracture preferences predict that southeast of the intersection, groundwater flow would continue southeast on the north side of Rt-32 and trending southwest on the south side of Rt-32.



5.0 Task IV - Monitoring Well Installation

5.1 Well Drilling

To better understand the complexity of the Gamber area (comprising seven open OCP cases) eight (8) locations were chosen by MDE for instillation of monitoring wells. As you are aware, access permission from two (2) property owners was denied for three (3) of the proposed wells and the resulting well locations were modified by the MDE to six (6) wells on the following properties:

Table 2 – Monitoring Well Locations

MW-1	Discover Carpets (Greenprop Inc.)	3950 Sykesville Rd	Parcel 173
MW-2	Discover Carpets (Greenprop Inc.)	3950 Sykesville Rd	Parcel 173
MW-3	Dix, Jeffrey O.	1701 Sandra Lane	Parcel 295
MW-4	Dix, Jeffrey O.	1701 Sandra Lane	Parcel 295
MW-5	Brower, David (Hill prop)	4016 Sykesville Rd.	Parcel 328
MW-6	Souders, Clarence	1702 Georgia Ave	Parcel 320

Utility clearances and permits to drill wells were obtained by the MES contractor prior to well instillation (Appendix A). On the morning of October 23, 2006 personnel from MES, MDE and CCHD met the driller on site. MES personnel were on site each day to oversee the project and keep a daily field log. Between October 23, 2006 and October 27, 2006, Bassett Environmental Associates, Inc., Harrisburg, PA, installed six (6) monitoring wells. The borings were advanced using 8" OD x 4" ID hollow stem augers and driving a split spoon sampler every 5-feet ahead of each auger (standard penetration test). The description of the material encountered from auger cuttings and from the sampler, as well as the moisture and the number of blows to drive the spoon, were logged by the on-site MES geologist and are included in appendix A. The sample collected in the split spoon was analyzed for organic vapor present with a PID meter and the two (2) samples from each boring, having the highest readings on appositive basis, were collected for laboratory analysis (EPA method 8260 + oxygenates). The results of the laboratory analysis are provided in appendix B. Although a strong petroleum odor was physically obvious in split spoon samples and auger cuttings, from borings MW-1 & MW-2, laboratory analysis results were non-detect for all twelve (12) samples sent for analysis. All soil auger cuttings and uncollected split spoon samples were sealed in thirty-four (34) 55-gallon drums, moved, and temporarily stored at a central storage location behind the Discover Carpet building with the owner's permission. Each drum was sampled using a thin wall sample tube to extract a representative sample. The samples from seventeen (17) drums was mixed together and a 500 ml sample of the composite collected and labeled. The two (2) composite samples were sent for laboratory analysis (EPA method 8260 + Total Petroleum Hydrocarbon (TPH)) to determine the proper disposal method. Test results (Appendix B) were non-detect for both samples and the cuttings were landfilled. A copy of the hauler's invoice and the MES Direct Purchase Order for disposal can be found in Appendix B.

5.2 Well Instillation

The borings were advanced to a depth below the water table. A 2" diameter, flush joint threaded, PVC, schedule 40 casing with a #10 slot well screen 20'–30' long was then installed through the augers. Well gravel was added through the augers as they were

removed. The gravel pack was continued to a depth of 2 to 5 feet above the top of the screen. A 2-foot bentonite clay layer was added to seal the gravel and the remainder of the annulus was grouted with portland cement to within 2 feet of the surface. The well was closed with a locking cap and a protective manhole cover installed in concrete. After completion of the drilling, well development and sampling tasks, the drilling sites were restored by filling ruts and spreading grass seed, straw and mulch.

5.3 Well Development

On October 31, 2006 the wells were developed by pumping the well with a 1.5-inch submersible pump until each well pumped clear water. All water punped was filtered through a drum of activated carbon before discharge to the ground surface. An attempt was made to remove all mud from the bottom of each well, however, due to the low yield of the wells, a decision was made to raise the pump above the mud and continue development from above the mud layer.

5.4 Subsurface Geology and Well Construction Summary

A total of 355 feet of soil borings enabled the installation of six (6) monitoring wells and development of a geologic profile for the area. Depth to water below the top of casing was measured prior to well development. Although the collection of "Shelby Tube" samples was included as part of the proposed action plan, the quarts vein layers encountered in all borings precluded the collection. Data from the MES boring logs and the logs of the wells at Highs and Royal Farms as well as MES survey data was used to prepare geologic cross sections A-A' (Figure 7) and B-B' (Figure 8). The locations of those sections are shown on Figure 6. All boring logs can be found in Appendix A. Table 2 below summarizes the MES well construction details.

The following is a generalized description of the material encountered during the drilling phase:

- Surface - Surface material at MWs 1 & 2 (Discover Carpet) consisted of asphalt paving over crushed stone. Wells MW 3 – 6, were drilled in grassy areas and penetrated approximately one foot of dark brown topsoil.
- Soil - Below the topsoil, the soil matrix was brown to reddish brown clayey silt or brown micaceous silt with weathered quartz veins, to depths varying from 5 to 25 feet. This layer was characterized as not having significant schist-like appearance and lower blow counts.
- Saprolite - The next horizon encountered was a saprolite with schistose appearance, brown with red and black staining and quartz veins, mica rich. This layer is highly weathered while retaining the layering/foliation layering of the parent rock.
- Soft Rock – Schist. Moderately hard, brown with black stains, quartz veins, micaceous layering, spoon refusal, foliation nearly vertical. Depth to hard rock varied from 31 to 58 feet below land surface. All borings except MW-2 encountered soft rock.

Table 3 - Gamber MES Well Construction Data

Well Number	Date Completed	Well Screened	Gravel Packed	Bentonite Seal	Cement Grout	Depth to Water
MW-1	10/27/06	36-56'	29-56'	27-29'	1.5-27'	38.9'
MW-2	10/26/06	30-50'	27-30'	23.5-27'	1.5-23.5	38.6'
MW-3	10/24/06	43-63'	31-63'	29-31'	1.5-29'	44.0'
MW-4	10/24/06	35-55'	31-55'	29-31'	1.5-29'	36.1'
MW-5	10/26/06	40-60'	30.5-60'	28.5-30.5'	2-28.5'	41.2'
MW-6	10/25/06	40-70'	35-70'	33.5-35'	1.5-33.5'	43.6'

6.0 Task V – Monitoring Well Sampling

6.1 Well Sounding

Before sampling of the newly installed wells, all area monitoring wells, including those at Royal Farms and Highs, were sounded to compare water table elevations for determining ground water flow. The three (3) monitoring wells at the High's store and the three (3) Royal Farms Store monitoring wells were surveyed for locations and surface elevations. Depth to top of casing, depth to water and depth to bottom was hand measured using an optical interface probe by MES (accompanied by MDE personnel to obtain access) on November 29, 2006. No free product was encountered in the wells. Information on the six (6) MES installed monitoring wells was also collected prior to purging and sampling. The following chart summarizes that information and was used to develop groundwater contours and predict groundwater flow direction (Figure 9).

Table 4 – Monitoring Well / Water Table Elevations

Well Number	Well Screened (BELOW SURFACE)	Depth to Bottom	Elev of Rim	Rim to TOC	Elev. Of Top Casing (Meas Point)	Depth to Water Nov-06	Water Table Elevation
MES MW-1	36-56'	54.6	655.286	0.4	654.9	37.8	617.1
MES MW-2	30-50'	49.5	655.09	0.75	654.3	37.2	617.1
MES MW-3	43-63'	51.6	647.403	0.9	646.5	42.8	603.7
MES MW-4	35-55'	55.6	633.355	0.3	633.1	33.8	599.3
MES MW-5	40-60'	59.7	640.798	0.5	640.3	40.1	600.2
MES MW-6	40-70'	60.0	636.885	0.25	636.6	37.0	599.6
HIGHS H-1	20-50'	48.9	651.192	0.3	650.9	33.7	617.2
HIGHS H-2	20-50'	49.6	649.462	0.5	649.0	32.2	616.8
HIGHS H-3	21-51'	50.7	651.192	0.3	650.9	34.6	616.3
ROYAL RF-1	10-35'	34.1	639.983	0.45	639.5	25.8	613.7
ROYAL RF-2	10-35'	34.6	639.145	0.7	638.4	24.3	614.1
ROYAL RF-3	15-45'	45.2	640.715	0.3	640.4	37.6	602.8

6.2 MES Monitoring Well Sampling

Based on the sounding data, the casing water volumes were calculated for each well. The six (6) MES installed monitoring wells were purged of 3-times the casing volume using a purge bailer. When initially attempting to purge MW-3 with a 1½ inch submersible pump, the pump became stuck at a depth of 51.5 feet below the top of the casing.

Attempts to retrieve the pump were unsuccessful. Consequently, all tubing and electrical lines were removed from above the top of the pump using a fishing tool. The depth shown in Table 3 for depth to bottom for MW-3 is to the top of the pump. Since the pump is below the top of the well screen, it did not interfere with purging with a hand bailer. MES is confident that the inert construction materials used in the pump will not and has not affected the sample results.

Gauging and sampling was performed on November 30 and December 1, 2006. All purge water was treated through a granular carbon filter (GAC) prior to surface discharge. A new disposable polyethylene sample bailer was then used to collect a sample from each well. The purge bailer and measuring equipment was decontaminated prio to and after each well sampling using laboratory grade detergent (Liqui-Nox) and rinsed with deionized water. Samples were analyzed on site for dissolved oxygen (DO), oxidation-reduction potential (ORP), pH, turbidity and conductivity. Two (2) - 40ml vials were collected from each well along with a trip blank (prepared in the lab), field blank (prepared in the field with deionized water) and duplicate sample. A stream identified as a potential receptor and located down hill from the Mey residence, was also sampled. Samples were placed in a cooler with ice and sent for laboratory analysis at Atlantic Coast Laboratories, Inc. (ACL), of Newark Delaware, on December 1, 2006 according to EPA Method 8260 plus fuel additives. The Chart below summarizes the field measurements taken:

Table 5 - Field Water Quality Measurements

	DO g/L	ORP mv	pH	Turbidity ntu	Conductivity S/cm	Temp °C
MW-1	14.1	227	5.3	>800	4.31	16.1
MW-2	8.4	256	5.5	>800	2.08	16.3
MW-3	7.6	265	6.1	936	1.06	16.1
MW-4	6.5	254	6.0	970	0.45	15.2
MW-5	11.5	258	5.6	906	1.32	14.8
MW-6	10.5	257	5.7	>800	0.85	14.8
Stream	9.6	216	6.8	23	0.43	15.5

6.3 Quality Assurance / Quality Control

In addition to the QA / QC performed by the contract lab, one trip blank, one field blank and one duplicate sample were collected and analyzed to establish quality control for sampling and handling techniques. The Trip Blank was filled with Deionized water at the MES laboratory, the field blank was prepared on-site with deionized water. The field blanks and trip blanks measure potential contamination from bottles, preservatives and transportation procedures. A duplicate sample insures lab testing QA/QC by testing two samples taken from the same source at the same time. A duplicate sample from MW-2 was chosen since petroleum odors encountered during drilling and development of the well indicated that it could have the highest VOC level. Laboratory testing results of all sample taken during this study can be found in appendix B.

6.4 Chain of Custody

Appropriate Chain of Custody forms were filled out during each sampling event. Each soil and groundwater sample collected was marked and recorded on the form using unique sample designations. The sample number, location, date and time of sample was

preserved as required by the test methodology and relinquished to the laboratory personnel. A copy of the Chain of Custody for each sampling event is included with the laboratory analytical data in Appendix B.

6.5 Monitoring Well Laboratory Water Quality Results

Table 6 summarizes the laboratory testing results for samples taken from all monitoring wells at Highs, Royal Farms and the wells installed for this investigation.

7.0 Task VI – GIS Development

As part of this report, all spatial and analytical data was incorporated into GIS database in ArcView 9. Site Maps showing, property boundries, well locations and completion data, analytical results of all well sampling and groundwater contours are included in this report and the GIS database. Geologic cross-sections were developed in CADD format to illustrate the subsurface lithology as well as the groundwater flow. A description of survey methods and data acquired for this study can be found in Task II.

8.0 Task VII – Site Assessment Report

8.1 Results of the investigation

The results of the site survey and monitoring well gauging were used to produce a map of groundwater contours (Figure 9). The flow of groundwater perpendicular to the contours suggests movement from the intersection of Rt-32 and Rt-91 toward the south – southeast. This direction of flow is consistent with elevation contours and fracture trace patterns.

Laboratory analysis of water samples from the new monitoring wells installed for this study, as well as samples taken from the monitoring wells at Highs and Royal Farms, can be found in Table 6. This data, together with the sampling results of water from commercial and residential wells in the study area (Table 7), was used to define the area of contamination above MCLs. Plotting the contaminants and concentrations suggests that there are two (2) separate sources (see Figure 10).

8.2 MTBE Plume

MTBE was found at the highest concentrations in the Royal Farms monitoring well RF-3 in July 2005. MDE records indicates problems with diesel fuel in two (2) sumps with evidence of weeping and spill catch basins improperly maintained (March 05) and quantities of product observed in catch basins and sump (June 05). The sampling of the Royal farms drinking well in March 2005 resulted in MTBE levels at 37.8 ppb and monitoring well RF-3 sampled in July 2005 had MTBE at 290 ppb. MTBE above the action level (20ppb) was found in downgradient domestic wells at the Martin (25 ppb), Weidman (45 ppb) and Brower (39 ppb) residences. The problems at Royal Farms were subsequently corrected and the system tested tight (July 2005). Since that time, MTBE levels have reduced to either non-detect or below the action level in those drinking wells. Monitoring well MW-5 (the new monitoring well closest to Royal Farms) sampled December 2006, indicates low levels of VOCs are still persistant. The last sample taken from Royal Farms monitoring well RF-3, on 6/13/06, had an MTBE level of 21 ppb.

8.3 Volitile Organic Compounds (VOC) Plume

MDE records show that the Mey, Dix and Bean (Discover Carpet) drinking wells had shown VOC contamination above MCLs as far back as July 2003. The nature of the contaminants suggests a refined petroleum source that has decayed into secondary components. Two monitoring wells were installed near the former tank field in front of Discover Carpets (MW-1 & 2). Soil samples taken at these locations had strong petroleum odor at 29 feet below land surface; however, laboratory analysis of the soils was recorded as non-detect. Water Samples taken from those wells on December 1, 2006 had very high levels of petroleum breakdown products (Table 5) most notably Benzene (489 ppb) and Zylene (1810 ppb). Benzene above the MCL (5 ppb) and other breakdown components were also found at lower levels in downgradient wells MW-3 (5.8 ppb) and MW-4 (125 ppb) as well as the Bean (16.5 ppb) Dix (52 ppb) and Mey 76 ppb) drinking wells. High concentrations of Benzene in MW-1 (489 ppb) as well as the localized direction of groundwater flow, indicate the old UST field, in front of Discover Carpet, may possibly be the source of this contamination.

8.4 Recommendations

MTBE Plume

It appears that overtime the MTBE plume has dispersed or is dissipating. MES suggests that MDE maintain the residential GACs and continue sampling. The objective would be to monitor and sample for an additional year. If MTBE stays below the detection level, the case could go for closure.

VOC Plume

The VOC Plume encompasses monitoring wells MW-1, MW-2, MW-3, MW-4 and the Discover, Dix, and Mey domestic wells. The highest concentrations of VOCs were found in MW-1 and MW-2. In addition, the soils encountered when drilling MW-1 and MW-2 were field noted as having a strong petroleum odor at or just above the water table. Although the plume extends well beyond MW-1 & MW-2, to downgradient wells, the focus of continuing site work should be an effort at this area (MW-1 & 2) as a potential primary source. MES recommends remedial work to include air sparging with soil vapor recovery. Treatment of the vapors could be managed by either large capacity vapor phase carbon or through a catalytic oxidizer unit. A pilot test to determine the radius of influence of the individual sparge and extraction points of the system could be set up on the lot in front of the Discover Carpet store. A detailed cost estimate can be developed at MDE's request.

A budgetary estimate of cost is as follows:

Install Well Points (dependent on results of pilot test)	$30,000
Utility Drop (dependent on technology)	3,000
Trenching (estimated)	5,000
Stone & Piping (estimated)	3,000
Fencing / shelter	2,000
Compressor & Blower	5,000
Catalytic Oxydizer or Carbon Filter	*
Carbon (estimated)	4,000
Labor (dependent on technology)	25,000
Soil Disposal (estimated)	3,000
Pilot Test (estimated)	3,000
Total (estimated)	$83,000

*The cost for the Oxydizer and possibly other equipment may be reduced if State owned equipment can be utilized